A SURVEY ON VARIOUS TEXT DETECTION AND EXTRACTION

TECHNIQUES FROM VIDEOS AND IMAGES

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ABSTRACT

Text extraction from still images and videos are on high demand these days in the area of multimedia for data retrieval and many other. Text extraction from the videos is a challenging task in image processing because of complex and sometimes highly illuminated background in videos it is quite complicated to extract text from the running video. Video segmentation and key frame extraction play an important role in extraction of text from a video. This paper present a brief study on how different methods and algorithms that have been used till date for text extraction from videos and still images. Through there are number of existing literatures to image processing and segmentation, we attempt to give a more elaborate image for a comprehensive review. With some tables and figures, we brief in the content.

KEYWORDS: Text Detection, Extraction, Information Extraction, Edge-Based, Texture-Based, Region-Based

Original Article

INTRODUCTION

Video is a visual multimedia source that combines a sequence of images to form a moving picture. The video transmits a signal to a screen and processes the order in which the screen captures should be shown. The use of digital video is increasingly found everywhere. Efficient access to such digital video involves indexing, retrieval, querying and browsing and much more [1].As we all know video is the most popular media type delivered via TV broadcasting, Internet, and wireless network. To enable users to quickly locate their interested content in an enormous quantity of video data [2] then just the data.

Video technology was first developed for mechanical television systems, which were quickly replaced by cathode ray tube (CRT). First video tape recorder (1951) captured live images from television cameras by converting the camera's electrical impulse and saving the information onto magnetic video tapes. The use of different digital

Techniques in videos created digital videos, which further allowed higher quality and eventually much

Lower cost than earlier analog technology. After the invention of DVD (1997) and Blu-ray Disc (2006)

Use and sale of videotapes and recording equipments drop sharply. Advance in the computer technology

allowed even inexpensive personal computers to capture, store and edit digital videos thus reducing the cost of video production.

Text Extraction from Videos

Text in the videos frames provide the much useful information about the video. However, due to the complex background in video frames, it is difficulties in detecting and localizing the text from the video frames. Text in the videos can be of particular interest as:

- It is intuitive and helpful for understanding video contents for viewers;

- Stories and objects in the videos are often directly described by texts;

- Text can provide valuable information, such as scene locations, speaker names, program introductions, sports scores, special announcements, dates and time [4];

- Text can be employed in keyword-based image search, text based image indexing and retrieval [5];

- Text-Based analysis algorithms are usually more reliable than audio based or image-based ones, since many existing commercial optical character recognition (OCR) systems are more robust than the speech analysis techniques and visual object analysis systems [6–9].

Video text extraction usually contains two parts: text location and text segmentation. Text location mean that where the text in the video is located and text segmentation in which the localized text is divide in segments based on the intensity of the image [4]. Text in video appears as either scene text or graphic text. Scene text is text contained in the scene and graphic text is informational text that mixes pictures and words.

EXTRACTING INFORMATION FROM TEXT

Information comes in different sizes and shapes and among them the most important form is structured data. In which there is a regular organization of entities and relationship. Information extraction is being employed for finding structured information from an unstructured or a semi-structured text. Thus text extraction is a process by which one can convert printed or scanned document or image which contain text to ASCII character that a computer system can recognize. It basically consists of four stages.

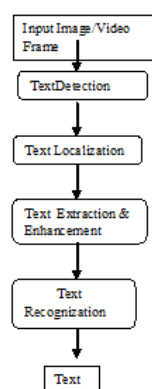The following stages are presented in the flow chart below:

Figure 1

- Text detection is detecting whether the text is present in the image or not

- Text localization i.e. where the position of the text in the image.

- Text extraction and enhancement in this step the text is extracted from the image and enhancement of the text is done if required like noise removal, edge detection and many more.

- Text recognition here the extracted text is segmented from the background to facilitate its recognition by performing OCR on binarized text image.[32-34]

TECHIQUNES FOR TEXT DETECTION LOCALIZATION AND EXTRACTION

A wide range of text extraction techniques has been arrived in recent past. These techniques can broadly be classified in three categories region based, edge based and texture based.

- **Region- Based Technique**

This approach utilize the different regional properties to extract text objects. This technique make use of the fact that there is sufficient difference between the text color and its immediate background. This works in bottom up fashion by initially segmenting the small regions and lastly grouping the potential text regions. Region based methods are generally composed of three modules[]. (1) Segmenting the image into small regions which aims at segregating the character regions from its background, (2) Merging and grouping of small regions to form words and sentences (3) Differentiating between text and non text objects.

- **Edge-Based Technique**

Edges are considered as a very important portion of the perceptual information content in an image. An edge is typically extracted by computing the derivative of the image. Edge-based text extraction algorithm is a general-purpose method, for effectively localize and extract the text from both indoor/outdoor images.

- **Texture-Based Technique**

Texture based technique is related to textural properties of the text to help it distinguish it from the background. This approach gives better result in complex background as compared to the region based technique but it is computationally very heavy and hence not suitable for retrieval systems for bulky databases. This works in top-down extracting texture region of the image and then locating the text region.

Text detection, localization and extraction from the still images and videos has been a vigorous research topic for decades and review of all the text detection localization and extraction methods is impossible. So survey of some papers related to the proposed system are mentioned as below in a tabular forms below

Where:

Table 1 describe the methodology used in the proposed work and the features.

Table 2 describes the benefits and the limitations of the reviewed research papers in the above table.

Table 1: Review of the Different Methodologies

Year	Author	Proposed Work	Methodology Used	Features
1995	Laurence Likforman-Sulem [10]	A Hough Based Algorithm for Extracting Text Lines in Handwritten Documents	Text lines are extracted in handwritten documents using an iterative hypothesis-validation strategy.	Information gathered from both the Hough domain and the image are combined.
1996	James Z. Xu [11]	Text String Location on Images	A non-directional search using a scoring scheme, a directional search employing pruning heuristics, a string growth technique using graphical constraints.	A systematic approach for extracting character strings on unconstrained maps.
1997	Jiangying Zhou[12]	Extracting Text from WWW Images	A text detection algorithm which is based on color clustering and connected component analysis.	The algorithm first quantizes the color space of the input image into a number of color classes using a parameter-free clustering Procedure.
1998	Erel Ortacag[13]	Locating Text in Color Document Images	A novel text extraction algorithm from cluttered color document images is developed.	Extraction of text segments algorithm uses the measurement of geometrical properties as well as characterness properties and a set of heuristic rules.
1998	Anil K. Jain[14]	Automatic Text Location in Images and Video Frames	Automatic text location deals with extracting image regions that just contain text.	We localize text through multivalued image decomposition.
1999	Raashid Malik[15]	Extraction of Text in Images	In this a text segmentation technique that is useful in locating and extracting text blocks in images.	The approach was motivated from knowledge of various characteristics of printed lettering or fonts and issue to determine a useful characteristic that may be utilized for text segmentation.
1999	Ullas Gargi[16]	A System for Automatic Text Detection in Video	System for detecting, tracking, and extracting artificial and scene text in MPEG–1 video.	The approach uses a battery of different methods employing a variety of heuristics for detecting, localizing text
2000	C. S. Shin[17]	Support Vector Machine-Based Text Detection in Digital Video	Support vector machine (SVM) for the texture classifier.	A SVM is trained to classify a pixel in the video frame by analyzing the textural properties of its local neighborhood.
2001	A. Miene[18]	Extracting Textual Inserts from Digital Videos	The approach combines a region-based color segmentation with heuristics a method for restoring small parts of characters lost.	No priori knowledge is needed concerning font type, size, color, and location of the text insert within the frame.
2002	Rainer Lienhart[19]	Localizing and Segmenting Text in Images and Videos	A complex-valued multilayer feed-forward network trained to detect text at a fixed scale and position.	Input images and videos can be of any size due to a true multi resolution approach. The system is also able to track each text line with sub-pixel accuracy.
2003	Qiviang Ye[20]	A Robust Text Detection Algorithm in Images and Video Frames	An algorithm that uses edge feature and morphology operation are to locate edge dense image blocks and SVM classifier to identify text from candidate text boxes.	The initial detection is based on Sobel edges feature and the verification uses the wavelet-based features and a SVM classifier.

Table 1: Contd.,				
2004	Datong Chen[21]	A localization/verification scheme for finding text in images and video frames based on contrast independent features and machine learning methods.	The approach used was a localization/verification scheme.	Contrast independent features are then proposed for training machine learning tools in order to verify the text regions.
2005	Michael R. Lyu[5]	A Comprehensive Method for Multilingual Video Text Detection, Localization, and Extraction	They performs analysis of multilingual text. Based on the analysis, a comprehensive, efficient video text detection, localization, and extraction method.	The text detection is carried out by edge detection, local thresholding, and hysteresis edge recovery.
2006	Basavaraj Amarapur[22]	Video Text Extraction from Images For Character Recognition	An algorithm for text extraction from images for character recognition is developed.	The text extraction algorithm is use to reduce the number of false text extraction region.
2007	Jingchao Zhou[23]	A Robust System for Text Extraction in Video	Utilizes a multiple stage verification scheme to detect text, which can maintain a high recall rate .	It cannot process motion text due to the assumption of stationary caption text.
2008	Tianding Chen[24]	Text Localization Using DWT Fusion Algorithm	Text localization method using discrete wavelet transform and neural network	The processing time is much fast because of 2D DWT used in the approach.
2009	Xiaodong Huang[25]	A New Video Text Extraction Approach	A character segmentation method which can accurately locate the character boundary in the text row.	Perform text extraction in single character, which is got by text character segmentation.
2010	Xin Zhang[26]	A Combined Algorithm for Video Text Extraction	Video Text Extraction Transition map, canny operator	The color-edge combined algorithm combines the edge feature and the color feature of the text.
2011	Z. Li G. Liu[27]	Effective and efficient video text extraction using key text points	video text extraction scheme using key text points (KTPs).	Improve the accuracy of text localization and verification
2012	Mohammad Khodadadi[28]	Text Localization, Extraction and In painting in Color Images	Image gradient, image histogram to estimate background and text color and In painting algorithm based on texture synthesis	Fast algorithm which needs only one iteration.
2013	Anubhav Kumar [3]	An Efficient Text Extraction Algorithm in Complex Images	Line edge detection mask, vertical and horizontal projection.	Automatically detect, localize , extract horizontally aligned text in images
2014	B.H.Shekar [29]	Discrete Wavelet Transform and Gradient Difference based approach for text localization in videos	Text frame identification, Discrete wavelet transform, gradient difference and false positive elimination	A non-horizontal text lines are scene text.
2015	Monika Singh[30]	An Efficient Hybrid Scheme for Key Frame Extraction and Text Localization in Video	It uses color moments and DWT for text extraction and morphological operations.	Help in reducing the computational/processing time of the algorithm**.**
2015	Manish Kumar[31]	Preventing Character Recognition Attacks on CAPTCHA: A Customizable CAPTCHA Approach	Captcha mechanism on various security parameters such as distortion, transparency, character set etc.	Provides a description for working of CAPTCHA.
2015	Sanjay Chandra Arya [32]	Image De-noising in Hand Written Document for Degraded Documents using Wiener Filter Algorithm	Wiener Filter Algorithm	A holistic word recognition approach for degraded documents.

Table 2: Benefits and Limitations

Year	Author	Benefits	Limitations
1995	Laurence Likforman-Sulem	At each stage of the process, a text –line hypothesis is obtained by searching the best alignment of connected components in the Hough domain.	The lack of data bases for handwritten documents and the fact that handwritten documents do not constitute a homogeneous class, both hinder the quantitative evaluation of segmentation methods.
1996	James Z. Xu	In MSM mode there is no dependency on The string selection. Vital in processing text-dense and unconstrained map regions.	In SSM mode, a very small percentage of the strings generated are slightly dependent on the selections of the strings starting objects.
1997	Jiangying Zhou	The algorithm works reasonably well given The complexity of the input data, suggesting that such techniques could prove useful in Web-based information retrieval applications.	The issue with the approach is the recognition of WWW image text. The algorithm was not robust.
1998	Erel Ortacag	Extract text from complex color consisting of a color segmentation stage followed by systematic elimination of non text blobs. Rule based scheme on more than one Segmentation map furnishes robustness. algorithm.	The results are not accurate.
1998	Anil K. Jain	Solution to the problem of locating text in a number of different domains, including classified advertisements, embedded text in synthetic Web images, color images and video frames	The time required for extracting text from the color image is more.
1999	Raashid Malik	The algorithm works without prior knowledge of the text orientation, size or font. It is designed to eliminate background image information and to highlight or identify the regions of the image that contain text.	The approach would not work properly with most OCR programs if background image information exists in a document image.
1999	Ullas Gargi	The system is to be able to detect unconstrained scene and artificial text in MPEG video. The text may be moving or have poor contrast in cluttered backgrounds.	Recognition of multi-font text is a problem which is not addressed by the system.
2000	C. S. Shin	The gray level values of raw pixels are directly fed to the classifier.	The proposed method was only able detected 94.5 % of the text regions in a set of test images and there was experimental error is due to low-level resolution.
2001	A. Miene	The approach works on stationary as well as on scrolling text inserts and also with text inserts which are softly faded in and out.	The fast pre selection of frames containing textual inserts in order to reduce the amount of data to be analyzed in detail is not possible.
2002	Rainer Lienhart	This text-detection and text-segmentation methods can be used for object-based video encoding.	In this approach only 88% of text location and extraction was possible.
2003	Qiviang Ye	has a good detection performance and is robust to language, font-color and size.	The temporal information of the video is not present.
2004	Datong Chen	provides fast text detection in images and videos with a low computation cost, comparing with traditional methods.	The approach was not able to localize the text when there is ambiguity.
2005	Michael R. Lyu	The proposed method is also robust to various background complexities and text appearances and method is also robust to various font sizes, font styles, contrast levels, and background complexities.	It cannot detect motion texts due to the assumption of stationary text and even non horizontally aligned texts cannot be localized.
2006	Basavaraj Amarapur	Algorithm is insensitive to skew and text orientation and free from artifacts that are introduced by both global and fixed size block based local threshold method and robust to noise.	The approach does not perform text analysis in the image.
2007	Jingchao Zhou	A efficient multiple stage verification scheme. A robust polarity estimation procedure. An effective connected component filtering method	A multiple frame enhancement methods is conducted to facilitate post-processing.
2008	Tianding Chen	capable of detecting and extracting text embedded in complex background	Back propagation rule of neural network takes a lot of time in training the weighting values and the processing time of neural network is very high.
2009	*Xiaodong Huang*	A quick character segmentation method based on the color edge map, which can locate the character boundary in the text row accurately. Robust to extract text character with complex background.	The proposed method was not applicable to the text whose character has no uniform color.
2010	Xin Zhang	Robust to the image with multilingual text.	The accuracy of text extraction is totally depends on training given to the Support Vector Machine(SVM).
2011	Z. Li G. Liu	The KTPs are merged by the morphological operations to locate the texts, and the proposed ATDP scheme significantly improves the efficiency and accuracy of text localization and verification.	The shortcoming of the proposed scheme is focused on detecting moving texts due to the assumption that texts are stationary in text tracking.
2012	Mohammad Khodadadi	Works well in text area with medium or high contrast	Failed when the text and background have very similar color.
2013	Abhinav Kumar	Average processing time is 1.13second/frame higher than other existing methods.	Text generated has a very low contrast and moving cars, trees, street lights, windows having

			the complex relation with the other objects in image.
2014	B.H.Shekar	Enable to handle non-horizontal text.	Limited to document images but not for videotext.
2015	Monika Singh	2-D DWT increases the efficiency of the algorithm by decreasing the computational time.	It can only partially detect the text in the video frames with complex backgrounds and high illumination.
2015	Manish Kumar	Describes the classification of various text based CAPTCHA schemes and their design flaws.	Captcha security
2015	Sanjay Chandra Arya	De-blurring or de noising of handwritten degraded documents	The time taken for execution for the code is more.

APPLICATIONS

The detection and extraction is in high demand these days and have many applications in different fields and even in our day to day lives. Some of the applications are listed below:

- In banking sector to read the credit cards

- In libraries to covert scanned page to image.

- At various government sectors for form processing.

- It is even used in car number plate recognition system

- Undesirable text removal from the images.

There are numerous number of applications though there are many challenges in at each level but the approach fulfill its goal of text extraction.

CONCLUSIONS

This paper aims to give a brief comprehensive review about a large number of literature on different techniques for text detection localization and text extraction from the videos and still images which is an important aspect in the field of information technology becoming increasingly vulnerable to new challenges due to the increase in the color complexity, image with complex background and high illumination and variable font size and style. Thus, the purpose of our paper is to have a survey of various algorithm and methodologies used till date with there performance, benefits and limitations by comparing them.

REFERENCES

1. *S. Antani, D. Crandall, R. Kasturi," Robust Extraction of Text in Video", Pattern Recognition, 2000. Proceedings. 15th International Conference IEEE,vol 1, pp:831-834,Sep 2000.*

2. *Michael R. Lyu Jiqiang Song, Min Cai," A Comprehensive Method for Multilingual VideoText Detection, Localization, and Extraction", ieee transactions on circuits and systems for video technology, vol. 15, no. 2, february 2005*

3. *Anubhav Kumar, "An efficient text extraction algorithm incomplex images", Proceeding of ICE IEEE 2013, pp 6-12.*

4. *Tang, X., Gao, X., Liu, J., Zhang, H.: 'A spatial-temporal approach forvideo caption detection and recognition', IEEE Trans. Neural Netw.,2002, 13, (4), pp. 961–971*

5. *Jung, K., Kim, K.I., Jain, A.K.: 'Text information extraction in imagesand video: a survey', Pattern Recogn., 2004, 37, pp. 977–997*

6. *Qian, X., Liu, G., Wang, H., Su, R.: 'Text detection, localization, andtracking in compressed video', Signal Process. Image Commun.,2007, 22, pp. 752–768*

7. *Sato, T., Kanade, T.: 'Video OCR: Indexing digital news libraries byrecognition of superimposed captions', Multimedia Syst., 1999, 7, (5),pp. 385–395*

8. *Lyu, M.R., Song, J.Q., Cai, M.: 'A comprehensive method formultilingual video text detection, localization, and extraction', IEEE Trans. Circuits Syst. Video Technol., 2005, 15, (2), pp. 243 -255*

9. *Sanjay Chandra Arya, Rajesh Shyam Singh Hardwari Lal Mandoria,"A Study and Analysis on Image Detrosing filters for handwritten document",IJRIT,Vol 3,Issue 12,pp:15-20*

10. *Laurence Likforman-Sulem, Andd Hanimyan, Claudie Faure," A Hough Based Algorithm for Extracting Text Lines inHandwritten Documents", Document Analysis and Recognition, 1995., Proceedings of the Third International Conference on (Volume:2),IEEE, pp: 774 – 777,Aug 1995.*

11. *James Z. Xu, Minsoo Suk, Sanjay Ranka," TEXT STRING LOCATION ON IMAGES", Signal Processing, 1996., 3rd International Conference , IEEE, Pages: 1354 - 1357 vol.2, Year: 1996.*

12. *JiangyingZhou; D.Lopresti,"Extracting text from WWW images",Document Analysis and Recognition,Proceedings of the Fourth International Conference Volume: 1,IEEE, pp: 248 - 252,1997.*

13. *A.K.Jain; BinYu,"Automatic text location in images and video frames",Pattern Recognition, Proceedings. Fourteenth International Conference,IEEEVolume: 2, Pages: 1497 – 1499,Year: 1998.*

14. *E.Ortaçağ; B.Sankur; K.Sayood,"Locating text in color document images",Signal Processing Conference (EUSIPCO 1998), 9th European,IEEE, Vol 1, pp: 1 – 4Year: 1998*

15. *R.Malik; SeongAhChin,"Extraction of text in images",Information Intelligence and Systems, International Conference,IEEE, Pages: 534 - 537,Year: 1999*

16. *U.Gargi; D.Crandall; S.Antani; T.Gandhi; R.Keener; R.Kasturi,"A system for automatic text detection in video",Document Analysis and Recognition, Proceedings of the Fifth International Conference,IEEE, vol 2, Pages: 29 – 32,Year: 1999.*

17. *C. S. Shin; K. I. Kim; M. H. Park; H. J. Kim,"Support vector machinebased text detection in digital video", Neural Networks for Signal Processing X, IEEE Volume: 2, pp: 634 – 641, Year: 2000*

18. *A. Miene; T. Hermes; G. Ioannidis; A. Christoffers,"Extracting textual inserts from digital videos",Document Analysis and Recognition, Proceedings. Sixth International Conference of IEEE, Pages: 1079 – 1083, Year: 2001.*

19. *R.Lienhart; A.Wernicke,"Localizing and segmenting text in images and videos",IEEETransaction on Circuits and Systems for Video TechnologyVolume:12, Issue: 4,Pages: 256 - 268, Year: 2002.*

20. *QixiangYe; WenGao; WeiqiangWang; WeiZeng,"A robust text detection algorithm in images and video frames",Information, Communications and Signal Processing, and Fourth Pacific Rim Conference IEEE, Volume: 2,Pages: 802 – 806, Year: 2003*

21. *Datong Chen, Jean-Marc Odobez, Jean-Philippe Thiran,"A localization/verification scheme for finding text in imagesand video frames based on contrast independent features and machine learning methods", Signal Processing,IEEE 19 (2004) 205–217*

22. *B.Amarapur; N.Patil,"Video Text Extraction from Images for Character Recognition",Electrical and Computer Engineering, 2006. CCECE '06. Canadian Conference,IEEE,Pages: 198 – 201, Year: 2006*

23. *Jingchao Zhou; Lei Xu; Baihua Xiao; Ruwei Dai, "A robust system for text extraction in video",Machine Vision, 2007. ICMV 2007. International Conference ,IEEE,Pages: 119 – 124,Year: 2007*

24. *TiandingChen,"Text localization using DWT fusion algorithm", Communication Technology,11th IEEE International Conference , Pages: 722 – 725,Year: 2008.*

25. *X.Huang; H.Ma; H.Zhang,"A new video text extraction approach"Multimedia and Expo,. IEEE International Conference , Pages: 650 – 653Year: 2009*

26. *Xin Zhang, Fuchun Sun and Lei Gu, "A combined algorithm forvideo text extraction", Proceedings of the 2010 SeventhInternational Conference,IEEE, pp: 2294-2298, 2010*

27. *Z.Li; G. Liu; X. Qian; D. Guo; H. Jiang,"Effective and efficient video text extraction using key text points",IET Image Processing,IEEE, Volume: 5, Issue: 8, Pages: 671 – 683,Year: 2011.*

28. *Mohammad Khodadadi and Alireza Behrad, "Text localization,extraction and inpainting in color images", Proceedings of 20th Iranian Conference on Electrical Engineering (ICEE), pp. 1035-1040, 2012.*

29. *B. H. Shekar, Smitha M.L, P. Shivakumara, "Discrete wavelettransform and gradient difference based approach for textlocalization in videos", in Proc. 2014 Fifth InternationalConference on Signal and Image Processing, pp. 280-284*

30. *M.Singh; A.Kaur,"An efficient hybrid scheme for key frame extraction and text localization invideo",Advances in Computing, Communications and Informatics (ICACCI), 2015 International Conference IEEE, Pages: 1250 – 1254,Year: 2015.*

31. *Manish Kumar, Rajesh Shyam Singh Hardwari Lal Mandoria," Preventing Character Recognition Attacks on CAPTCHA: A Customizable CAPTCHA Approach", International Journal for Research in Emerging Science and Technology, volume-2, issue-7, july-2015*

32. *Sanjay Chandra Arya, Rajesh Shyam Singh Hardwari Lal Mandoria," Image Denoising in Hand Written Document for Degraded Documents using Wiener Filter Algorithm", International Journal for Research in Emerging Science and Technology, volume-2, issue-7, july-2015.*

33. *Sanjay Chandra Arya, Rajesh Shyam Singh Hardwari Lal Mandoria, "Analysis of a Novel Custom CAPTCHA Security Method with Existing CAPTCHA Mechanisms", IJRIT International Journal Of Research In Information Technology, Volume 3, Issue 9, September 2015, Pg. 106-112*

34. *Sanjay Chandra Arya, Rajesh Shyam Singh Hardwari Lal Mandoria," Analysis of Various Parameters on a Novel Custom Captcha Security Method",I nternational Journal of Engineering Research & Management Technology,Volume2 Issue6,2015*

35. *Sanjay Chandra Arya, Rajesh Shyam Singh Hardwari Lal Mandoria," Image De-noising using Wiener Filter Algorithm" IJ RI T, Volume 3, Issue 9, September 2015, Pg. 13-23*